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MODEL 301A

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MANUFACTURERS OF PRECISION ELECTRONIC INSTRUMEN

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APPLICABLE TO INSTRUMENTS
WITH SERIAL NUMBERS 2176
AND ABOVE.

MODEL 301A

INSTRUCTION MANUAL

CUSHMAN
ELECTRONICS, INC.

5601-0049-1

September 1978

CUSHMAN INSTRUMENT WARRANTY

All instruments manufactured by Cushman Electronics, Inc. are warranteed against defects in material and workmanship for a period of one year from the date of original shipment. Cushman will repair or replace instruments, which prove to be defective, in accordance with the following policy. This policy does not apply to repair service, parts sales, nor does it apply to instruments, or parts of the instrument, which in the opinion of Cushman, have been altered or misused.

All Countries

- During the first three months after the date of original shipment, no charge for parts, replacement PC boards, labor, or freight for instruments serviced at an authorized Cushman Service Center. Free freight applies only within the customer's country. Method of transportation shall be designated by an authorized Cushman representative or Service Center.

- During the fourth through the twelfth month after the date of original shipment, no charge for parts, replacement PC boards, and labor for instruments serviced at an authorized Cushman Service Center. All transportation charges for instruments, parts, or replacement PC boards shall be paid by the customer during this period.

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In the U.S.A. and Canada an additional two year limited warranty is offered extending from the 13th until the 36th month from the date of original shipment. This warranty is effective beginning with instruments purchased on or after April 1, 1977. During this period, the following limited warranty policy applies:

- No charge for parts* used by an authorized Cushman Service Center to repair an instrument.

- Cushman will replace at no charge, PC boards which are found to be defective by an authorized Cushman Service Center. Defective boards must be returned to Cushman in accordance with Cushman's PC board exchange policy.

- All transportation charges for instruments, parts, and replacement PC boards shall be paid by the customer during this period.

* Cathode ray tubes and batteries excluded.

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SECTION 1
GENERAL

DESCRIPTION

1.01 The Model 301A Oscilloscope displays the peak-to-peak frequency deviation of FM carrier signals, either received or generated by the Communications Monitor. The vertical display is calibrated in three deviation ranges: ±1.5 kHz, ±5 kHz and ±15 kHz. An automatic sync circuit instantly locks the sweep to the incoming signal.

1.02 The CRT screen permits accurate visual analysis of the modulation signals. Any abnormal conditions, such as unbalanced modulation, signal distortion, clipping or power supply pulses may be easily observed.

1.03 The Model 301A may also be used as a general purpose oscilloscope. External vertical and horizontal connectors are provided for this purpose. The vertical input is calibrated for 5, 20, and 100 mV/DIV. An EXT VERT GAIN control permits adjusting the sensitivity to as high as 20, 100, and 400 mV/DIV in the uncalibrated mode.

1.04 The horizontal signal may be either from an external source, or the internal calibrated sweep may be used. Sweep calibration is 1, 10, 100, or 1000 μsec/DIV. In the uncalibrated mode the sweep time may be multiplied by as much as a factor of 10.

1.05 The bandwidth of both the vertical and horizontal amplifiers is identical in the external mode. The range is from 20 Hz to 100 kHz.

1.06 If desired, the recovered Audio from the FM discriminator may be brought out to the Vertical Input BNC connector, by connecting an optional jumper on the vertical amplifier board. This output may be connected to any equipment having a fairly high (100kΩ) input impedance. (If this jumper is connected, no signal source should be connected to the VERT INPUT connector when the VERT INPUT switch is in the INT position.)

1.07 The specifications for the Model 301A Oscilloscope are given in Table 1-1.

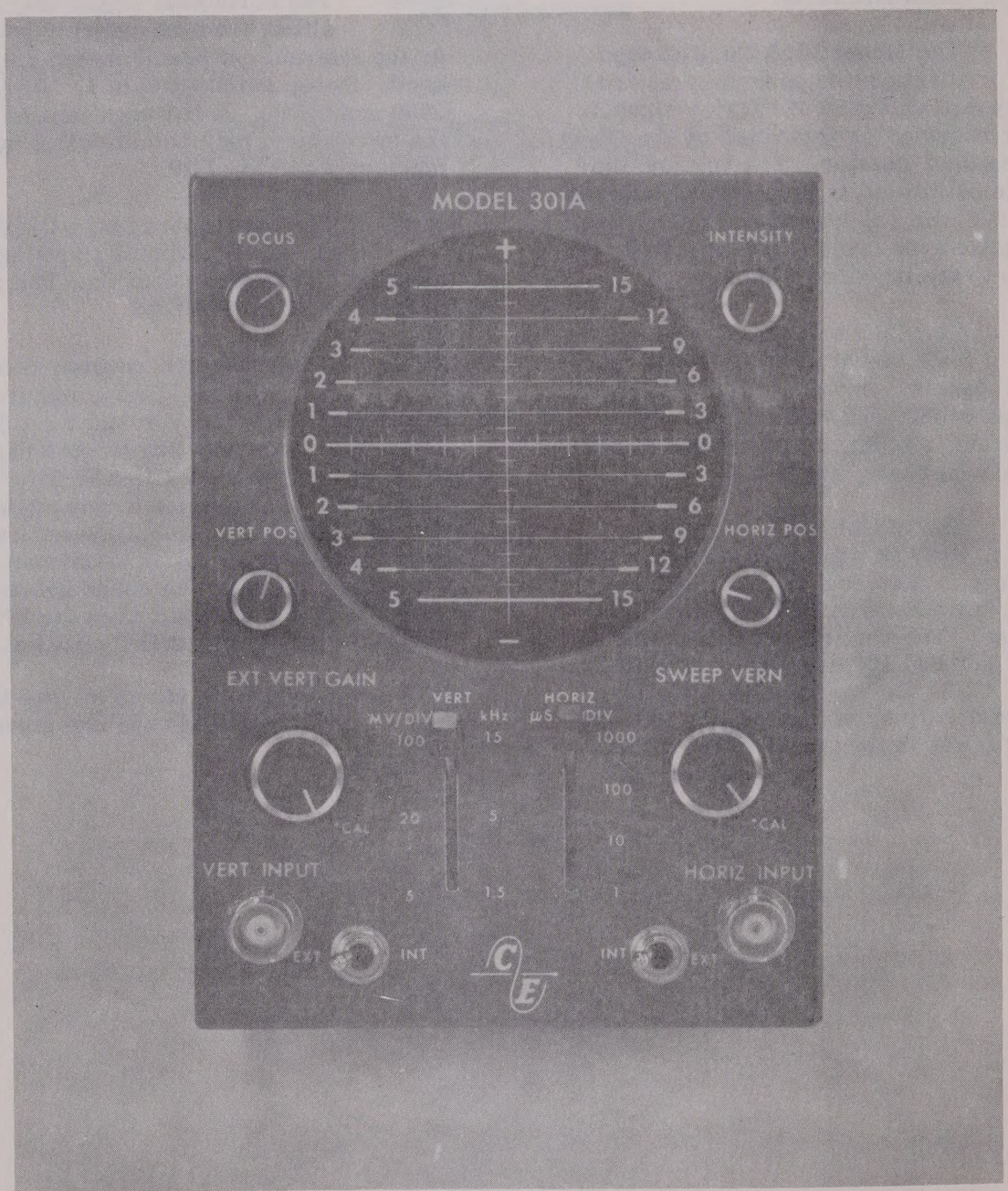

Figure 1-1. Model 301A Oscilloscope

TABLE 1-1. Model 301A Specifications

COMMUNICATIONS MONITOR COMPATIBILITY	CE-3, CE-5, CE-6, CE-7
VERTICAL INPUTS, INTERNAL MODE	
SENSITIVITY*	
±1.5 kHz	300 Hz/DIV ±5%
±5 kHz	1 kHz/DIV ±5%
±15 kHz	3 kHz/DIV ±5%
FREQUENCY RESPONSE (-3 dB BW)	DC to 5 kHz min.
DIVISION CALIBRATION, CRT GRATICULE	10 DIV/2 inches
VERTICAL INPUTS, EXTERNAL MODE	
MAXIMUM INPUT VOLTAGE	10 V RMS
SENSITIVITY, CALIBRATED	5 mV/DIV ±5% 20 mV/DIV ±5% 100 mV/DIV ±5%
UNCALIBRATED	
5mV/DIV	5-20mV/DIV
20mV/DIV	20-100mV
100mV/DIV	100-400mV/DIV
FREQUENCY RESPONSE	20 Hz to 100 kHz min.
INPUT IMPEDANCE	1MΩ, 30 pF
HORIZONTAL INPUTS, INTERNAL MODE	
SWEEP SPEEDS, CALIBRATED	1ms/DIV ±5% 100μs/DIV ±5% 10μs/DIV ±5% 1μs/DIV ±10%
UNCALIBRATED	
1 ms/DIV	10ms-1ms/DIV
100μs/DIV	1ms-100μs/DIV
10 μs/DIV	100μs-10μs/DIV
1 μs/DIV	10μs-1μs/DIV
DIVISION CALIBRATION, CRT GRATICULE	10DIV/2 inches
HORIZONTAL INPUTS, EXTERNAL MODE	
MAXIMUM INPUT VOLTAGE	10 V RMS
SENSITIVITY	50mV/DIV nominal
FREQUENCY RESPONSE (-3 dB BW)	20 Hz to 100 kHz min.
INPUT IMPEDANCE	1MΩ, 30pF

* When calibrated with it' s mating Disriminator in the Communications Monitor

TABLE 1-1. Model 301A Specifications (cont)

VERTICAL OUTPUT (Audio from FM Discriminator) AT VERTICAL CONNECTOR WITH INTERNAL JUMPER	
OUTPUT IMPEDANCE	330Ω in series with 0.1μF
OUTPUT LOAD	Must be greater than 100kΩ
OUTPUT LEVEL	10mV-1V p-p typical (310mV p-p with ±5 kHz Dev. Typical)
CRT CHARACTERISTICS	
DIAMETER	2.75 inches (7 cm)
PHOSPHOR	P1, Medium Persistance, Yellowish-Green
POWER REQUIREMENTS, from Communications Monitor	
AC	115V/230V ±10% 48-62 Hz, 400 Hz ±10%, 0.17 amps (typical at 115V)
DC	+20V, 65mA, typical -12V, 110mA, typical
DIMENSIONS	
HEIGHT	5 1/2" (13.97 cm)
WIDTH	4" (10.16 cm)
DEPTH	13" (33.02 cm)
WEIGHT	5 lbs. (2.27 kg)
ENVIRONMENTAL	
TEMPERATURE	
OPERATING	0°C to +55°C
STORAGE	-40°C to +75°C
HUMIDITY	90% RH, 40°C
VIBRATION	10-55 Hz .01" (.25 mm) p-p
SHOCK	4" (10.16 cm) bench drop
ALTITUDE	
OPERATING	15,000 ft. (4.57 km)
NON-OPERATING	25,000 ft. (7.62 km)

SECTION 2
INSTALLATION

UNPACKING AND INSPECTION

2.01 When unpacking the Model 301A Oscilloscope, inspect the packing box and the instrument for damage. The Oscilloscope was carefully inspected before shipment and should be ready to operate properly when received. Confirm satisfactory performance by following the procedures given in the Operating Instructions, Section 3, of the manual. If the instrument is damaged or fails to operate properly, file a claim with the transportation agency, or if insured separately, with the insurance company.

INSTALLATION

2.02 The Model 301A fits into the left hand compartment of the Communications Monitor. After placing in the compartment, turn the large slotted knob on the rear of the Communications Monitor in the clockwise direction until it is finger tight.

2.03 To remove the Oscilloscope from the Monitor, turn the large slotted knob on the rear of the Monitor counter clock wise until it is free of the plug-in. Then push the knob toward the Monitor until the plug-in separates from the connectors. It may then be easily removed from the compartment.

POWER REQUIREMENTS

2.04 All the required power is furnished by the Communications Monitor and is connected when the plug-in is installed in the compartment. The AC supply to the Oscilloscope plug-in is protected by a fuse. In the CE-3, CE-5, CE-6 this fuse is mounted on the rear of the plug-in panel in the Monitor. In the CE-7 this fuse is mounted on the Monitor rear panel adjacent to the main fuse.

PREPARATION FOR RESHIPMENT

2.05 It is recommended that the shipping box and foam packaging be retained in case it becomes necessary to return the instrument to the factory for service or repair. If further assistance is required, contact Cushman Electronics Customer Service Department.

2.06 If the instrument is to be shipped to the factory or a service center for service or repair, attach a tag to the instrument identifying the owner, and indicating the service or repair to be accomplished. Always include the model and serial number. In any correspondence, always identify the instrument by model and serial number, and part number if required. Before shipping an instrument, always contact the Cushman Electronics Customer Service Department for instructions and possible further assistance.

2.07 If the original container is to be used, proceed as follows:

a. Place the instrument in the original container. (If the original container is not available, one can be purchased from Cushman Electronics.)

b. Make sure the container is well sealed with strong tape or metal bands.

2.08 If the original container is not used, proceed as follows:

a. Wrap the instrument in plas-

tic or heavy paper before placing in an inner container.

b. Place instrument and inner container in a heavy carton or wooden box, and seal with strong tape or metal bands.

c. Mark the shipping container "DELICATE ELECTRONIC INSTRUMENT", "FRAGILE".

SERVICE OR REPAIR

2.09 In the event that service or repair of the instrument is required contact:

Cushman Electronics, Inc.
Customer Service Department
2450 N. First St.
San Jose, California 95131
Telephone: (408) 263-8100

2.10 Cushman Electronics service is also available at the following locations:

c/o B.C.S. Associates, Inc.
940 North Fern Avenue
Orlando, Florida 32803
Telephone: (305) 896-4881

c/o B.C.S. Associates, Inc.
1310 Beaman Place
Greensboro, North Carolina 27408
Telephone: (919) 273-1918

c/o Ossman Instruments
Service Corporation
6666 Old Collamer Road
East Syracuse, New York 13057
Telephone: (315) 437-7245

c/o Reshal Associates, Inc.
219 West University Drive
Arlington Heights, Illinois 60004
Telephone: (312) 398-7660

SECTION 3
OPERATION

GENERAL

3.01 The 301A Oscilloscope plug-in has the standard oscilloscope controls. See Figure 1-1. The controls and connectors with a brief explanation are listed in Table 3-1. Schematic references for the controls are found on the Interconnection diagram, Figure 6-1.

3.02 The right hand lever switch controls the sweep speed in the internal mode only. The external input goes directly to the horizontal amplifier and may be used for an external time base or for an x-y display.

3.03 The left hand lever switch adjusts the vertical gain in three steps. The numbers on the right hand side of the switch refer to the calibrated horizontal lines on the Oscilloscope graticule. This calibration applies when the Vertical switch is in the INT position. In the EXT position the calibration on the left hand side of the switch applies.

3.04 Before proceeding with a measurement, adjust FOCUS for the sharpest trace and adjust INTENSITY for desired brilliance of display. These controls interact slightly so adjustments should be repeated several times.

TABLE 3-1. Model 301A Controls and Connectors

CONTROL OR CONNECTOR	FUNCTION
FOCUS	Adjusts sharpness of trace
INTENSITY	Controls brilliance of trace
VERT POS	Vertically positions CRT display
HORIZ POS	Horizontally positions CRT display
EXT VERT GAIN	Continuously adjusts gain between Vertical gain switch position ranges. Must be in CAL position for switch ranges to apply
VERT MV/DIV	Millivolts per division for each setting of vertical gain switch, EXT mode.
kHz	kHz deviation for each setting of vertical gain switch, INT mode.
HORIZ μsec/DIV	Microseconds per division for each setting of horizontal sweep switch for the INT mode.
SWEEP VERN	Continuously adjusts sweep between the Horizontal sweep time switch ranges
VERT INPUT	BNC connector for external signals
EXT INT	Selects vertical external or internal mode
HORIZ INPUT	BNC connector for external signals
INT EXT	Selects horizontal internal or external mode

CAUTION

Prolonged display of a stationary spot of high intensity may damage the phosphor coating of the CRT screen. Intensity should, therefore, not be set higher than necessary for comfortable viewing.

High voltages are present inside the Oscilloscope. The plug-in should never be removed or replaced with the Monitor AC power switch in the on position. It is recommended that the AC power switch be turned off for at least 30 seconds before removing the plug-in to allow the high voltage capacitors to discharge.

DEVIATION MEASUREMENTS

3.05 Set up the Oscilloscope controls as follows:

EXT VERT GAIN	CAL
SWEEP VERN	CAL
VERT INPUT Switch	INT
HORIZ INPUT Switch	INT
HORIZ μ sec/DIV	Selected Sweep Speed
VERT kHz	Selected Deviation Range
VERT Pos	Center Display
HORIZ Pos	Center Display

3.06 Adjust the Communications Monitor for FM Deviation measurement according to the instruction manual procedure. Read the deviation according to the VERT switch setting in kHz and the numbered lines corresponding to the switch setting on the CRT graticule.

GENERAL PURPOSE MEASUREMENTS

3.07 Set the front panel controls as in paragraph 3.04 and 3.05 except set VERT INPUT switch to EXT. Connect external signal to the VERT INPUT connector. The vertical display will now be in millivolts per division, according to the setting of the VERT switch. The Sweep Speed will still be microseconds per division according to the setting of the HORIZ switch.

3.08 For an x-y display set both the VERT INPUT and HORIZ INPUT switches to EXT and connect the external signals to the VERT and HORIZ INPUT connectors. Vertical gain may be controlled with the EXT VERT GAIN control. Horizontal gain must be adjusted at the external signal source.

DISCRIMINATOR AF OUTPUT

3.09 Remove plug-in and connect terminals 3 and 45 on the 2100 Vertical Amplifier board. Replace plug-in. Discriminator AF output is now available at the VERT INPUT connector.

CAUTION

No external signal source should be connected to VERT INPUT when using VERT INT mode.

SECTION 4
THEORY OF OPERATION

INTRODUCTION

4.01 In this section the Circuit Reference Series for circuit and component identification is defined, the overall functioning of the instrument is explained and a description of the individual circuit boards is given.

CIRCUIT REFERENCE SERIES

4.02 The circuits of the instrument are referred to by the series 1000, 2100-2400 and 3000. The 1000 series refers to the front panel; 2100 is the Vertical Amplifier and Power Supply board; 2200 is the Horizontal Amplifier and Sweep Generator board, 2300 is the center plate assembly; 2400 is the CRT assembly and 3000 is the rear panel assembly.

4.03 In each circuit the components are individually numbered with a separate series for each type of component in each circuit. For example the first resistor on the Vertical Amplifier and Power Supply board is R2101, the fourth transistor is Q2104, the second capacitor is C2102, etc.

4.04 When the individual circuits are described in the Circuit Description section, the component references will be abbreviated. Only the component type and number, as R3 instead of R2103, will be used, except when referring to a component in another circuit. In this case the full Circuit Reference Series number will be used.

4.05 The circuits mounted on circuit boards may be identified by a number etched on each circuit board as follows:

Board No.	Circuit No.	Circuit Name
1780-0488	2200	Horizontal Ampl. & Sweep Gen.
1780-0489	2100	Vertical Ampl. & Pwr. Supply

FUNCTIONAL DESCRIPTION

4.06 Input to the Oscilloscope is either from the Discriminator circuit in the Communications Monitor or through the EXT VERT INPUT connector from an external source as selected with the EXT-INT switch. See Figure 4-1. In either case it passes through an attenuator to provide the calibrated ranges. The signal then goes through the Vertical Amplifier to the CRT vertical deflection plates. A reversing relay in the vertical plate connections maintains the proper polarity of the display when the Monitor mixing changes from the high to the low side and vice versa. This applies to the CE-3, CE-5, CE-7 only.

4.07 The horizontal deflection plates are driven by the Horizontal Amplifier with either the output of the calibrated ramp generator, or by an external signal or time base, through the EXT HOR INPUT, according to the setting of the horizontal INT-EXT switch. The ramp generator provides four different sweep speeds according to the setting of the front panel horizontal sweep speed switch.

4.08 The ramp output from the sweep is controlled by an automatic sync circuit which is triggered by an output from the Vertical Amplifier. This output is amplified in the Trigger Amplifier before being applied to the Automatic

Sync Circuit. With this circuit the CRT always shows a stable display.

4.09 All high voltages for the Oscilloscope are produced by a High Voltage power supply in the plug-in unit. AC is brought into the plug-in from the Monitor for this power supply. A fuse for this AC circuit is mounted on the rear panel of the plug-in compartment for all Monitors except the CE-7 where it is mounted on the main rear panel.

CIRCUIT DESCRIPTION

4.10 Vertical Amplifier. 2100

4.11 Output from the Discriminator in the Communications Monitor enters the plug-in through P3001-11, Figure 6-1, and goes to the Vertical Amplifier board pin 1, Figure 6-2. DC Adjust, R33, sets the input voltage to the Operational Amplifier buffer, IC1, so that the buffer output is at 0 VDC with no discriminator output. This is necessary so that there will not be a DC shift of the Oscilloscope trace when switching the VERT kHz ranges.

4.12 Signal output from the buffer goes to the base of Q3A. Q3A, Q4 and Q3B, Q5 form differential voltage series feedback pairs. The vertical amplifier is a high gain, wideband differential amplifier which provides push-pull outputs for the vertical deflection plates. The DC output level of Q3A, Q3B, is offset as R2303 is adjusted, thus adjusting the vertical position of the display.

4.13 The signal out of Q4 and Q5 is buffered by the emitter followers Q6, Q7 and drives the differential output amplifiers, Q8, Q9. The gain calibration adjustment of the Vertical Amplifier is made by R29 in the emitter circuit of Q8, Q9.

4.14 Output from the amplifier passes through reversing relay, K1. This signal polarity reversal is necessary to keep the polarity of the Oscilloscope display correct when the Communications Monitor mixing is shifted from the high side to the low side. This takes place in the CE-3, CE-5, and CE-7. The CE-6 always mixes on the high side.

4.15 When the INT-EXT switch is in the EXT position, input from the EXT VERT INPUT connector is buffered by a high input impedance source follower stage, Q1. Signal then goes through the Vertical Input Attenuator, R1, R2, R3, and is buffered to the Vertical Amplifier by emitter follower Q2.

4.16 If it is desired to externally monitor the Discriminator AF output, an internal jumper may be connected between terminals 3 and 45. This connects the Discriminator output to the EXT VERT INPUT connector through coupling capacitor, C8. Whenever the INT-EXT switch is in the INT position the Discriminator output will appear at the EXT VERT INPUT connector. When the switch is in EXT this signal is disconnected and the External Vertical input circuits operate normally. (If this jumper is connected, no signal source should be connected to the VERT INPUT connector when the VERT INPUT switch is in the INT position.)

4.17 Sweep Generator. 2200

4.18 The trigger signal is taken from the emitter of Q2107 through C2106 and brought to the sweep circuit through pin 25 to the base of Q7, Figure 6-3. CR3 protects against excessive trigger signals. Q7 buffers the input to amplifier Q6, which overdrives Q8 to produce essentially a square wave output. The 8V p-p square wave is attenuated in

R41, R43 and coupled to the base of Q11 through C10. The positive feedback from the collector of Q8 to the emitter of Q7 through R40 squares up the output from Q8

4.19 Q11 is on at the end of the sweep and remains on until the negative edge of the pulse out of Q8 turns it off. When Q11 is turned off Q9, Q10, Q12, Q13 are also turned off. The output of Q12 goes high to unblank the CRT beam. When Q13 is turned off CR2 is reverse biased and C5 starts to charge through constant current source, Q15 and the resistor selected by the front panel μsec/DIV switch, S1004.

4.20 As the voltage across C5 rises, forming the sweep ramp, source follower, Q14, couples this voltage to Q9 through R19, R20. This ramp voltage turns on Q9 at a point depending on the setting of R19, the sweep length adjustment. Q9 turns on Q10 and when Q10 conducts there is about a 5 volt drop at the emitters. C4 discharging through Q10 slows this 5 volt drop to approximately 2μsec, insuring sufficient current in R45 to keep Q10 on, to prevent retriggering until C5 is completely discharged. This turns on Q11, causing a regenerative effect through Q10, making Q10 and Q11 saturate very quickly. At the same time Q12 conducts, blanking the CRT. Q13 also conducts discharging C5. Current through R16, Q10, R45 keeps Q11 conducting until a negative trigger comes from Q8, at which time the cycle repeats. CR1 forces Q9 to turn off during retrace. The 8V p-p trigger signal from Q8 keeps C9 charged to about +4V so CR4 is back biased and is effectively an open circuit in the triggered mode.

4.21 When there is no trigger signal the sweep operates in a free running mode. Operation is the same as in and triggered mode except that with no trigger the collector of Q8 rests at 0V DC. C9 no longer has a charge so there is a 2 kΩ resistance path to zero potential (ground) through CR4. When Q10 is turned on causing C4 to discharge there is enough current in the collector circuit of Q10 through CR4, R42, R44 to produce a voltage high enough to turn on Q11. This turns on Q12, Q13, blanking the CRT, forcing Q9 to turn off and insuring sufficient time for C5 to discharge completely before starting a new sweep. After C4 has discharged there is insufficient current in the collector circuit of Q10 to keep Q11 turned on, so it turns off and the sweep starts again.

4.22 Horizontal Amplifier. 2200

4.23 Ramp output from the source follower, Q14, goes through biasing resistor, R24, through the INT-EXT switch to the input of source follower, Q1. Output from Q1 goes to the base of Q2. The Horizontal amplifier is a medium gain, wideband differential amplifier which provides push-pull outputs for the horizontal deflection plates. The output of Q2, Q3 is amplified by Q4, Q5, which drive the horizontal deflection plates of the CRT. R6 in the emitter circuit is the calibration gain adjustment for the INT mode.

4.24 When the INT-EXT switch is placed in the EXT position, R3 is shunted across the emitter resistance network R4-R7. This has the effect of increasing the gain of this stage approximately 5 times to provide the specified 50 mV/DIV horizontal input sensitivity.

4.25 The base of Q3 is connected to the slider of R2304, the front panel HORIZ POS control, which with R30, R31 forms a voltage divider between

+20V and -12V and controls the bias on the base of Q3 to adjust the horizontal position.

4.26 Power Supplies. 2100

4.27 The 920 VAC output of the power supply transformer, T3001, is connected to the voltage doubler rectifier CR11, CR12, C12, C13. The resistors R44-R47 are chosen to provide the current required for zener operation of the zener diode string CR1-CR10, at minimum line voltage. The CRT -1200V accelerating potential is set by the ten 120V zener diode string CR1-CR10. INTENSITY and FOCUS controls are tapped off between the zener diodes at the required voltages.

4.28 The low voltage power supply uses the 245 VAC output of the power transformer, T3001. The output is rectified by CR16 and the output filtered with C15. Q10 is the series regulator and the reference voltage is supplied by two 120V zener diodes, CR14, CR15, in series. The regulated output voltage is +240V. +130V for the astigmatism electrode of the CRT is tapped off between R51 and R52 of the bleeder resistor.

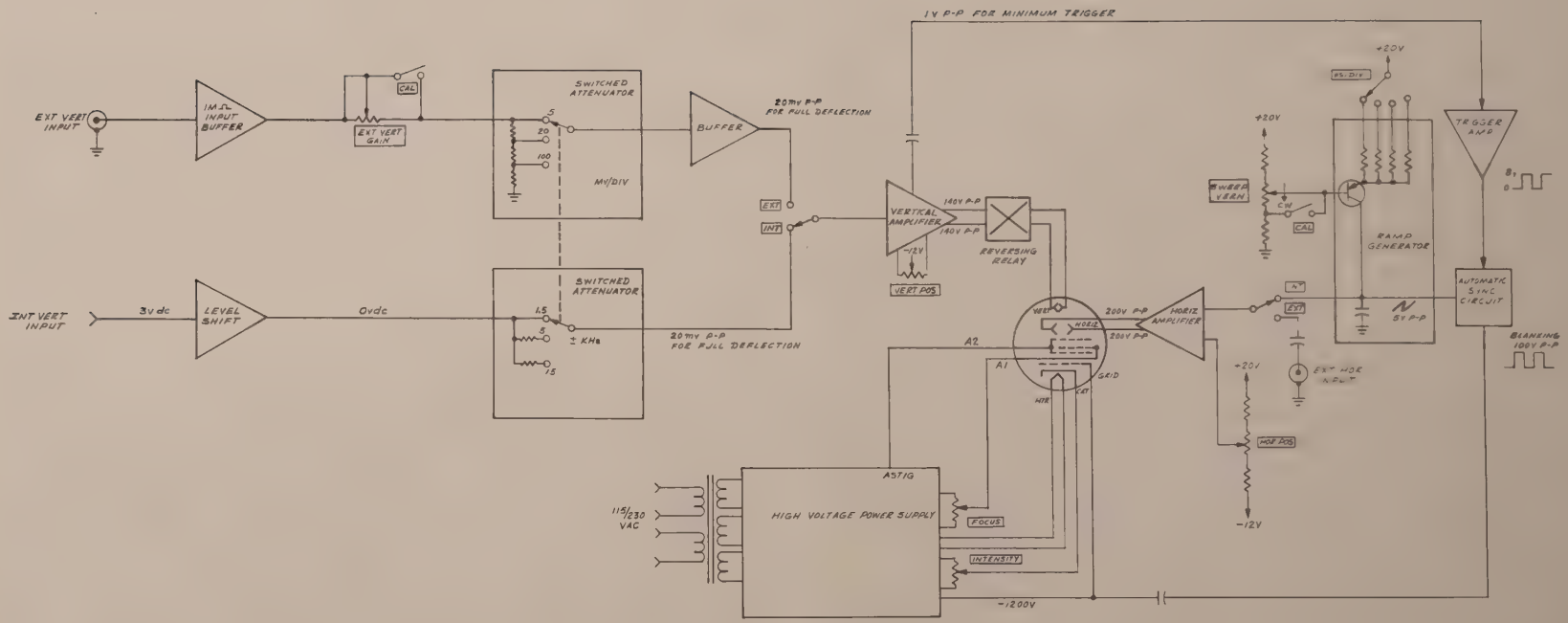

Figure 4-1. Model 301A Overall Block Diagram

SECTION 5
ADJUSTMENTS

INTRODUCTION

5.01 All adjustments should be made with the 301A Oscilloscope plugged into the Communications Monitor with which it is to be used. The adjustment controls are all accessible when the left side cover of the Monitor is removed.

ADJUSTMENT

5.02 The following test equipment is required:

Oscilloscope	HP180 with plug-ins, HP1801A, HP1820A or equiv.
Audio Osc.	HP200 or equiv.

5.03 Plug the 301A into the Monitor, turn on power to Monitor and set 301A controls as follows:

EXT VERT GAIN	CAL
SWEEP VERN	CAL
VERT MV/DIV	100
HORIZ μsec/DIV	1000
VERT INPUT	EXT
HORIZ INPUT	INT

5.04 Sweep Amplitude

5.05 On the Horizontal Amplifier board, 2200 (mounted vertically), connect the X10 probe of the Test Oscilloscope to WT2205 (collector of Q15). See component identification drawing, Figure 6-3.

a. Adjust the SWEEP AMPL control R2206 until the sawtooth waveform is 0V to 6V p-p.

5.06 Trace Alignment

5.07 Observe the trace on the 301A Oscilloscope. If it is not level, loosen the CRT clamp and rotate until it is level, according to the horizontal lines on the graticule.

5.08 Horizontal Gain

5.09 Connect a 1 kHz, 0.57 p-p signal to the VERT INPUT connector. Use Test Oscilloscope to monitor input signal amplitude.

a. Adjust HORIZ GAIN control, R2206, until the peaks of the sine wave line up with the eleven vertical marks on the horizontal zero line of the 301A graticule. Use the HORIZ POS and VERT POS controls to position the display as required.

5.10 External Vertical Gain

5.11 Adjust the 1 kHz input for 1V p-p signal to the VERT INPUT connector. Adjust EXT VERT GAIN control, R2129, for a full 10 divisions p-p display on the 301A Oscilloscope. See component identification drawing Figure 6-2.

5.12 Vertical Centering

5.13 Remove the signal from the VERT INPUT connector. There should be no input to the Monitor and Monitor FUNCTION switch should be set to CAL. There must be a plug-in unit in the right-hand compartment.

a. Center the trace to the zero graticule line with the VERT POS control.

b. Switch VERT INPUT to INT. The HORIZ μsec/DIV control should still be set to 1000. Set SWEEP VERN to CAL.

c. Set the DC ADJ control, R2133, so that the trace is

vertically centered on the zero graticule line.

5.14 Vertical Frequency

5.15 Calibrate the Frequency Meter on the Monitor. Set FUNCTION switch to CAL. Adjust the inner knob on the FUNCTION switch for a zero (mid-scale) reading on the FREQUENCY meter.

a. Set the 301A VERT kHz to 5. Center the CRT trace on the zero graticule line with the VERT POS control.

b. Switch Monitor Function switch to SIG GEN FM and adjust FM CAL control for zero reading on the Frequency Meter. Check that 301A trace is still on the zero line. Re-zero if necessary.

c. Set FM CAL control for a frequency meter reading of +5 kHz (full scale).

d. Adjust 301A INT V. GAIN control, R2134 until the trace rests on the +5 kHz line.

e. Set 301A VERT kHz to 15. Display should show +5 kHz, ±5%, on the 15 kHz graticule scale.

f. Set FM CAL control on the Monitor for a Frequency Meter reading of 1.5 kHz.

g. Set 301A VERT kHz to 1.5. The CRT display should be +1.5 kHz (full scale) ±5%.

SECTION 6
PARTS LISTS AND SCHEMATIC DIAGRAMS

INTRODUCTION

6.01 This section includes the parts lists, component identification drawings and the schematic diagrams of the Model 301A Oscilloscope. Each parts list and schematic diagram is identified by the Circuit Reference number. The component identification drawings are placed on the inner part of the schematic diagram sheets.

FRONT PANEL, CENTER PLATE, CRT, REAR PANEL ASSEMBLIES. 1000, 2300, 2400, 3000

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	301A Oscilloscope			
1000	Front Panel Assembly	7003-0078	Cushman	
	CAPACITOR			
C1	Poly, .1μF, 10%, 100V	1008-0031	Sprague	225P10491WA3
	CONNECTORS			
J1	BNC Jack, Panel Mount	2536-0010	King	KC79-35
J2	BNC Jack, Panel Mount	2536-0010	King	KC79-35
	RESISTORS			
R1/S1	Pot, 10k, ±20%, 1/2W, Lin. Taper	1203-0064	CTS	RGC-45-EF8135
R2/S2	Pot, 10k, ±20%, 1/2W, Lin. Taper	1203-0064	CTS	RGC-45-EF8135
	SWITCHES			
S1	P/O R1			
S2	P/O R2			
S3	Lever, 3 pos.	1851-0016	Cushman	
S4	Lever, 4 pos, 1 pole	1851-0080	Cushman	
S5	Toggle, 3 PDT	1850-0007	Alco	MST-305D
S6	Toggle, 3 PDT	1850-0007	Alco	MST-305D
2300	Center Plate Assembly	7013-0004	Cushman	
	RESISTORS			
R1	Pot, 500k, ±20%, 1/2W	1203-0038	Allen-Bradley	WA4G032S504MA
R2	Pot, 500k, ±20%, 1/2W	1203-0038	Allen-Bradley	WA4G032S504MA
R3	Pot, 1k, ±10%, 1/2W	1203-0035	Allen-Bradley	WA4G032S102UA
R4	Pot, 1k, ±10%, 1/2W	1203-0035	Allen-Bradley	WA4G032S102UA
2400	Cathode Ray Tube Assembly			
	CRT, 3RP1A	1270-0019	RCA	3RP1A
	Socket, 12 Pin	2605-0011	Cinch-Jones	3B12
	Shield (for 3RP1A)	2657-0068	Cushman	
R1	Comp, 2MΩ, ±5%, 1/4W	1066-2055	Allen-Bradley	CB2055
3000	Rear Panel Assembly	7003-0079	Cushman	
	CONNECTOR			
P1	Plug, 24 Pin Ribbon Type	2535-0019	Amphenol	26-159-24
	DIODE			
CR1	Si, 1N4002	1281-0023	Motorola	1N4002
	TRANSFORMER			
T1	Power, AC	1575-0007	Cushman	

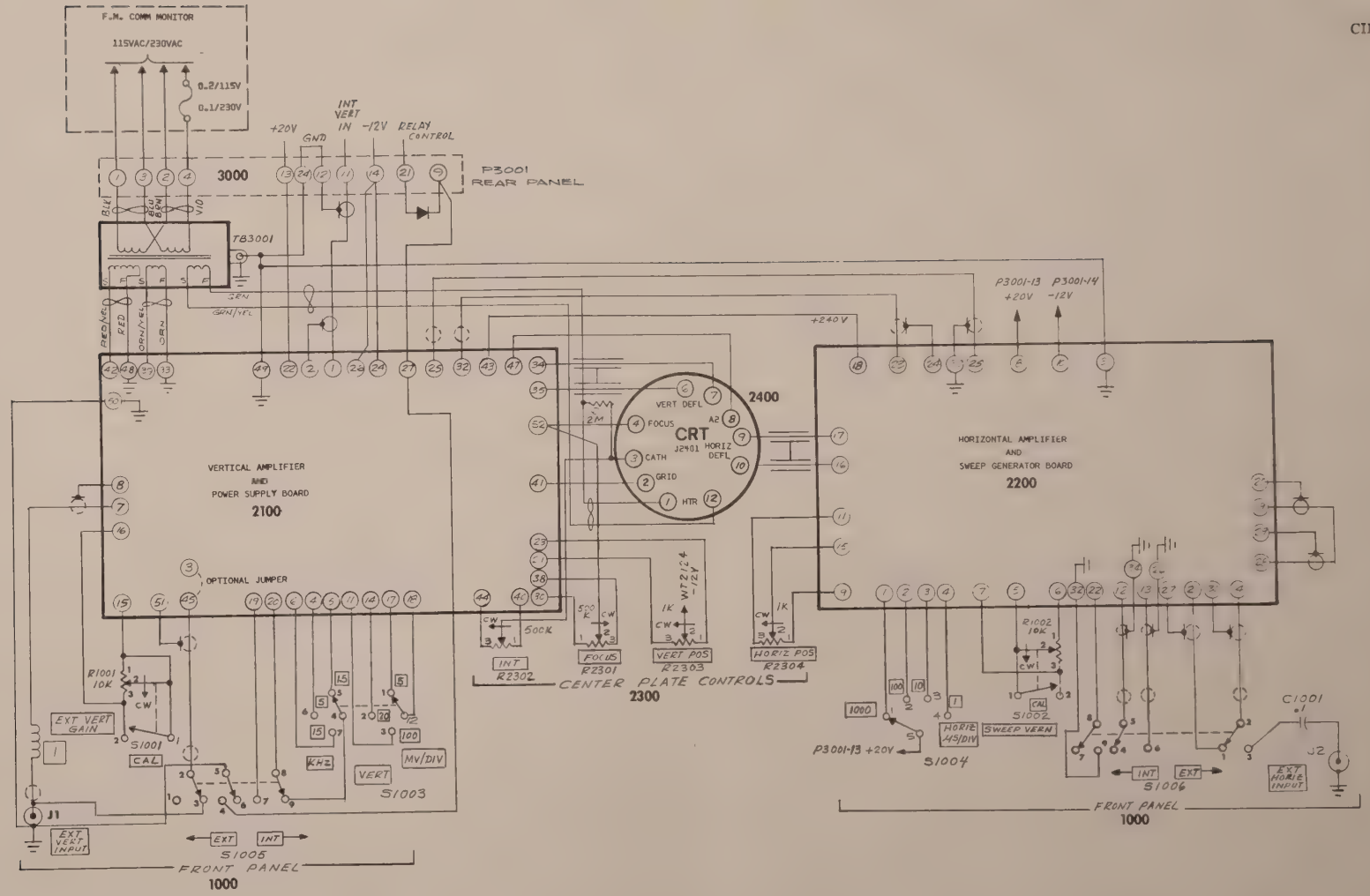

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Figure 6-1. Overall Interconnection Diagram 1000, 2300, 2400, 3000

VERTICAL AMPLIFIER/ POWER SUPPLY. 2100

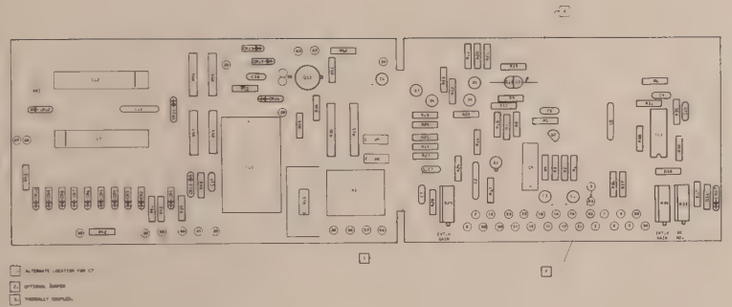
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	301A Oscilloscope			
2100	Vertical Amplifier/Power Supply Assembly	7001-0239	Cushman	
	P. C. Board	1780-0489	Cushman	
	CAPACITORS			
C1	Tant, 10μF, +50%-20%, 35V	1011-0006	ITT	TAG10/35-20
C2	Poly, .1μF, ±10%, 100V	1008-0031	Sprague	225P10491WA3
C3	Tant, 10μF, +50%-20%, 35V	1011-0006	ITT	TAG10/35-20
C4	Elect, 100μF, +75%-10%, 12V	1013-0011	Sprague	30D107G012CC5
C5	Mica, 270pF, ±5%, 500V	1002-0031	Elmenco	DM15-F-271J
C6	Tant, 10μF, +50%-20%, 35V	1011-0006	ITT	TAG10/35-20
C7	Mica, FSV, ±5%, 500V	1002-xxxx	Elmenco	
C8	Poly, .1μF, ±10%, 100V	1008-0031	Sprague	225P10491WA3
C9	Cer, .01μF, +80%-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C10	Cer, .01μF, +80%-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C11	Cer, .01μF, ±20%, 1.4kV	1005-0051	Sprague	125L-S10
C12	Met, Mylar, .047μF, ±10%, 4000V	1008-0083	F-Dyne	MPE 11H .047-4000-10
C13	Met, Mylar, .047μF, ±10%, 4000V	1008-0083	F-Dyne	MPE 11H .047-4000-10
C14	Cer, 47pF, ±20%, 3000V	1005-0045	Erie	838-Y5P2KV
C15	Elect, 20μF, +50%-10%	1014-0019	C-D	WB2-20-450 X
C16	Cer, .01μF, ±20%, 3kV	1005-0069	Sprague	30GA-S/10
	DIODES			
CR1	Zener, 120V, ±5%, 1/2W	1281-0077	Motorola	1N5273B
CR2	Zener, 120V, ±5%, 1/2W	1281-0077	Motorola	1N5273B
CR3	Zener, 120V, ±5%, 1/2W	1281-0077	Motorola	1N5273B
CR4	Zener, 120V, ±5%, 1/2W	1281-0077	Motorola	1N5273B
CR5	Zener, 120V, ±5%, 1/2W	1281-0077	Motorola	1N5273B
CR6	Zener, 120V, ±5%, 1/2W	1281-0077	Motorola	1N5273B
CR7	Zener, 120V, ±5%, 1/2W	1281-0077	Motorola	1N5273B
CR8	Zener, 120V, ±5%, 1/2W	1281-0077	Motorola	1N5273B
CR9	Zener, 120V, ±5%, 1/2W	1281-0077	Motorola	1N5273B
CR10	Zener, 120V, ±5%, 1/2W	1281-0077	Motorola	1N5273B
CR11	Si, VB-40	1281-0029	Varo	VB-40
CR12	Si, VB-40	1281-0029	Varo	VB-40
CR13	Si, 1N5062	1281-0030	GE	1N5062
CR14	Zener, 120V, ±5%, 1/2W	1281-0077	Motorola	1N5273B
CR15	Zener, 120V, ±5%, 1/2W	1281-0077	Motorola	1N5273B
CR16	Si, 1N5062	1281-0030	GE	1N5062
CR17	Zener, 6.2V, 1N827	1281-0038	Motorola	1N827
	INTEGRATED CIRCUIT			
IC1	High Perf, Op-Amp	2025-0022	T.I.	SN72741N
	RELAY			
K1	DPDT, 12V DC Coil	1313-0002	Signal Stat	175Y1
	RESISTORS			
R1	Metal Film, 750Ω, ±1%, 1/8W	1075-0043	Dale	MFF 1/8 T1
R2	Metal Film, 200Ω, ±1%, 1/8W	1075-0082	Dale	MFF 1/8 T1
R3	Metal Film, 49.9Ω, ±1%, 1/10W	1074-1038	Dale	MFF 1/10 T1
R4	Comp, 100k, ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
R5	Comp, 68Ω, ±5%, 1/4W	1066-6805	Allen-Bradley	CB6805

VERTICAL AMPLIFIER/POWER SUPPLY. 2100 (cont.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R6	Comp, 3.9k, ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R7	Metal Film, 102Ω, ±1%, 1/10W	1074-1040	Dale	MF 1/10 T-0
R8	Metal Film, 13k, ±1%, 1/8W	1075-0128	Dale	MFF 1/8 T-0
R9	Comp, 1.2k, ±5%, 1/4W	1066-1225	Allen-Bradley	CB1225
R10	Comp, 200k, ±5%, 1/4W	1066-2045	Allen-Bradley	CB2045
R11	Metal Film, 18.2k, ±1%, 1/8W	1075-0075	Dale	MFF 1/8 T-0
R12	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R13	Comp, 3k, ±5%, 1/4W	1066-3025	Allen-Bradley	CB3025
R14	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R15	Comp, 56k, ±5%, 2W	1069-5635	Allen-Bradley	HB5635
R16	Metal Film, 1MΩ, ±1%, 1/10W	1074-1039	Dale	MF 1/10 T-0
R17	Comp, 5.1k, ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R18	Metal Film, 13k, ±1%, 1/8W	1075-0128	Dale	MFF 1/8 T-0
R19	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R20	Metal Film, 18.2k, ±1%, 1/8W	1075-0075	Dale	MFF 1/8 T-0
R21	Comp, 200k, ±5%, 1/4W	1066-2045	Allen-Bradley	CB2045
R22	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R23	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R24	Comp, 3k, ±5%, 1/4W	1066-3025	Allen-Bradley	CB3025
R25	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R26	Comp, 12k, ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R27	Comp, 12k, ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R28	Comp, 5.1k, ±5%, 1/4W	1066-5125	Allen-Bradley	CB5125
R29	Pot, 5k, ±10%, 3/4W	1215-0012	Helitrim	89WR
R30	Comp, 56k, ±5%, 2W	1069-5635	Allen-Bradley	HB5635
R31	Metal Film, 3.24k, ±1%, 1/8W	1075-0092	Dale	MFF 1/8 T-1
R32	Metal Film, 3.24k, ±1%, 1/8W	1075-0092	Dale	MFF 1/8 T-1
R33	Pot, 500Ω, ±10%, 3/4W	1215-0011	Helitrim	89WR
R34	Pot, 1k, ±10%, 3/4W	1215-0013	Helitrim	89WR
R35	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R36	Metal Film, 909Ω, ±1%, 1/10W	1074-1036	Dale	MF 1/10 T-0
R37	Metal Film, 237Ω, ±1%, 1/10W	1074-1041	Dale	MF 1/10 T-0
R38	Comp, 330Ω, ±5%, 1/4W	1066-3315	Allen-Bradley	CB3315
R39	Comp, 100k, ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
R40	Comp, 100k, ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
R41	Comp, 100k, ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
R42	Comp, 100k, ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
R43	Comp, 1k, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R44	Comp, 120k, ±5%, 1W	1068-1245	Allen-Bradley	GB1245
R45	Comp, 120k, ±5%, 1W	1068-1245	Allen-Bradley	GB1245
R46	Comp, 120k, ±5%, 1W	1068-1245	Allen-Bradley	GB1245
R47	Comp, 120k, ±5%, 1W	1068-1245	Allen-Bradley	GB1245
R48	Comp, 100k, ±5%, 1/4W	1066-1045	Allen-Bradley	CB1045
R49	Comp, 82k, ±5%, 1/4W	1066-8235	Allen-Bradley	CB8235
R50	Comp, 680k, ±5%, 1/4W	1066-6845	Allen-Bradley	CB6845
R51	Comp, 160k, ±5%, 1/4W	1066-1645	Allen-Bradley	CB1645
R52	Comp, 200k, ±5%, 1/4W	1066-2045	Allen-Bradley	CB2045
R53	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R54	Metal Film, 562Ω, ±1%, 1/8W	1075-0041	Dale	MFF 1/8 T-1
R55	Metal Film, 825Ω, ±1%, 1/10W	1074-1000	IRC/TRW	RN55D
R56	Comp, 1k, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
	TRANSISTORS			
Q1	FET, N Chan, 2N4392	1272-0054	Teledyne	2N4392
Q2	NPN, 2N5962	1272-0059	Fairchild	2N5962
Q3	NPN, 2N5962	1272-0059	Fairchild	2N5962
Q4	NPN, Si, 2N3565	1272-0017	Fairchild	2N3565
Q5	NPN, Si, 2N3565	1272-0017	Fairchild	2N3565

VERTICAL AMPLIFIER/POWER SUPPLY. 2100 (cont.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
Q6	NPN, Si, 2N3565	1272-0017	Fairchild	2N3565
Q7	NPN, Si, 2N3565	1272-0017	Fairchild	2N3565
Q8	NPN, Si, MJE340	1272-0046	Motorola	MJE340
Q9	NPN, Si, MJE340	1272-0046	Motorola	MJE340
Q10	NPN, Si, MJE340	1272-0046	Motorola	MJE340
Q11	NPN, 2N5962	1272-0059	Fairchild	2N5962
Q12	NPN, 2N3440	1271-0004	RCA	2N3440



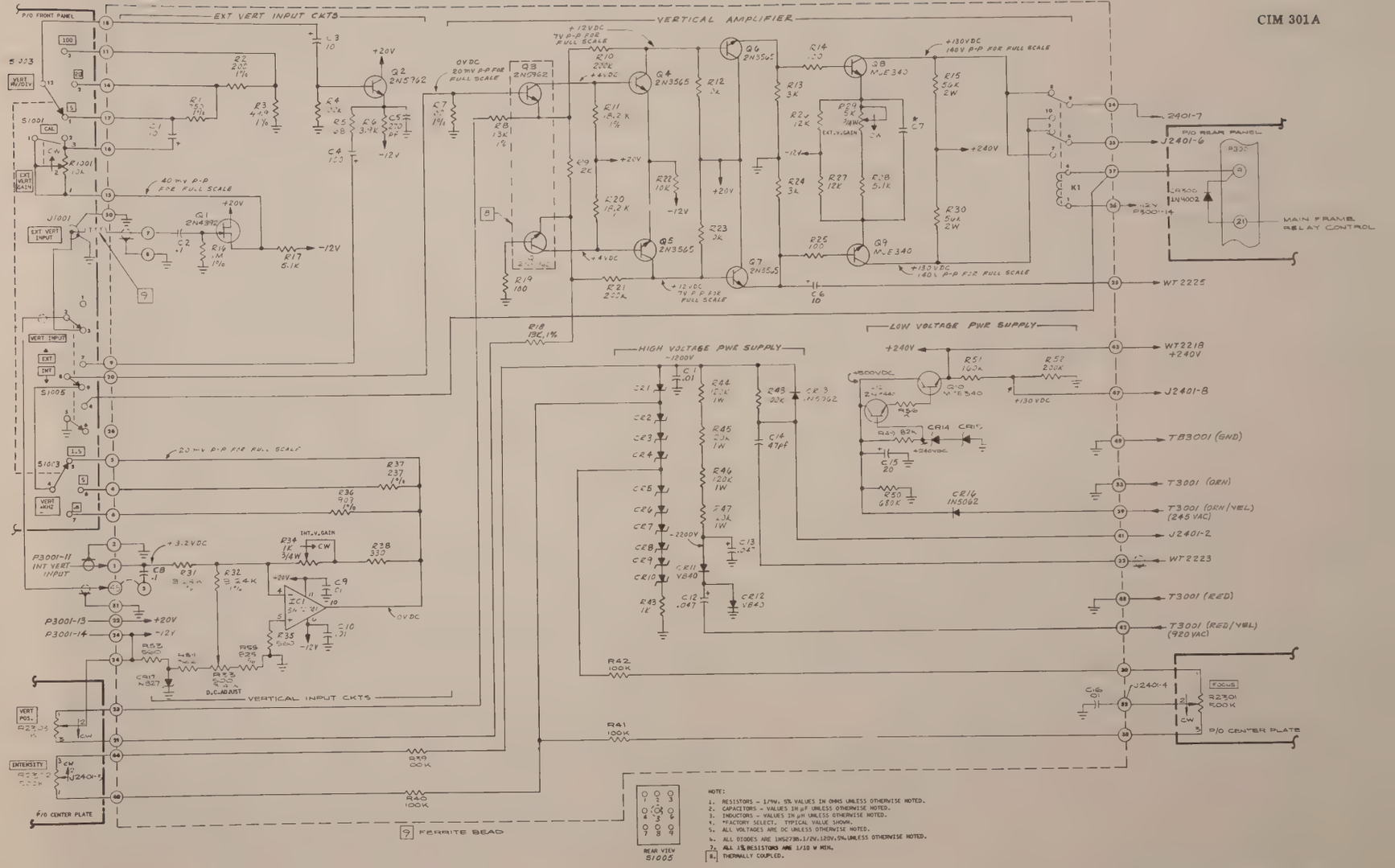


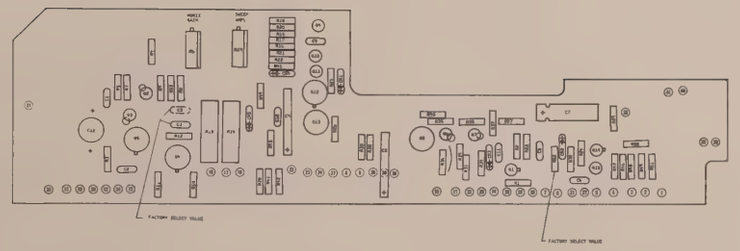
Figure 6-2. Vertical Amplifier/Power Supply. 2100

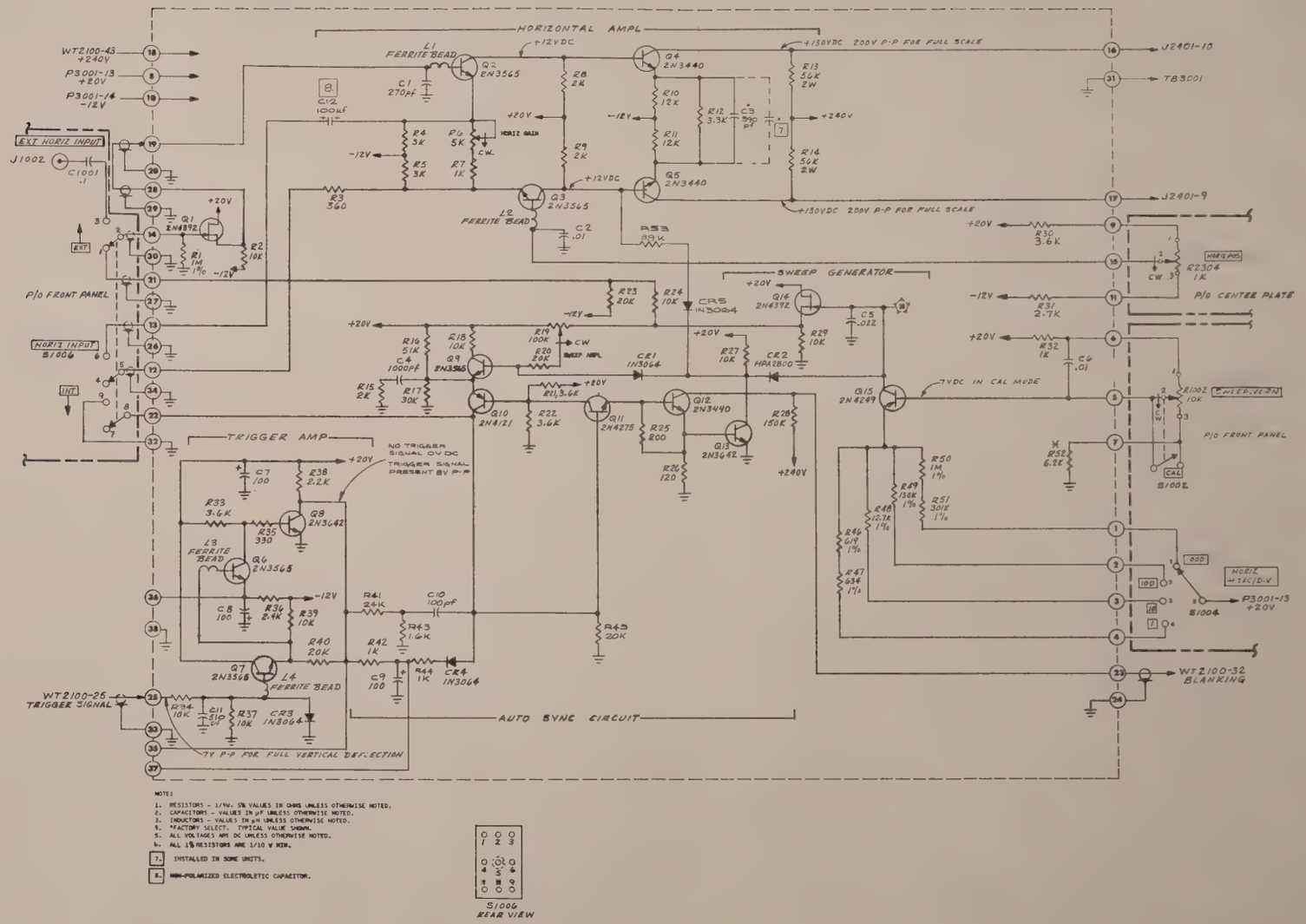
HORIZONTAL AMPLIFIER/SWEEP GENERATOR. 2200

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	301A Oscilloscope			
2200	Horizontal Amplifier/Sweep Generator Assembly	7001-0238	Cushman	
	P. C. Board	1780-0488	Cushman	
	CAPACITORS			
C1	Mica, 270pF, ±5%, 500V	1002-0031	Elmenco	DM15-F-271J
C2	Cer, .01μF, +80%-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C3	Mica, FSV, ±5%, 100V	1002-xxxx	Elmenco	
C4	Mica, 1000pF, ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C5	Poly, .022μF, ±10%, 100V	1008-0034	Sprague	225P82291
C6	Cer, .01μF, +80%-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C7	Elect, 100μF, ±10%, 25V	1013-0003	Sprague	30D1076025DD5
C8	Elect, 100μF, +75%-10%, 12V	1013-0011	Sprague	30D1076012CC5
C9	Elect, 100μF, ±10%, 25V	1013-0003	Sprague	30D1076025DD5
C10	Mica, 100pF, ±5%, 100V	1002-0011	Elmenco	DM15-F-101J
C11	Mica, 510pF, ±5%, 500V	1002-0036	Elmenco	DM15-F-511J
C12	Elect, 100μF, +100%-30%, 16V	1013-0029	Ill. Elna	BPR
	CHOKES			
L1	Choke, U-250, Ferrite bead	1586-0004	Ferroxcube	56-590-65/4B
L2	Choke, U-250, Ferrite bead	1586-0004	Ferroxcube	56-590-65/4B
L3	Choke, U-250, Ferrite bead	1586-0004	Ferroxcube	56-590-65/4B
L4	Choke, U-250, Ferrite bead	1586-0004	Ferroxcube	56-590-65/4B
	DIODES			
CR1	Si, 1N3064	1281-0013	Teledyne	1N3064
CR2	Si, Hot Carrier, HPA2800	1283-0001	HPA	5082-2800
CR3	Si, 1N3064	1281-0013	Teledyne	1N3064
CR4	Si, 1N3064	1281-0013	Teledyne	1N3064
CR5	Si, 1N3064	1281-0013	Teledyne	1N3064
	RESISTORS			
R1	Metal Film, 1MΩ, ±1%, 1/10W	1074-1039	Dale	MF 1/10 T-0
R2	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R3	Comp, 360Ω, ±5%, 1/4W	1066-3615	Allen-Bradley	CB3615
R4	Comp, 3k, ±5%, 1/4W	1066-3025	Allen-Bradley	CB3025
R5	Comp, 3k, ±5%, 1/4W	1066-3025	Allen-Bradley	CB3025
R6	Pot, 5k, ±10%, 3/4W	1215-0012	Beckman	89WR
R7	Comp, 1k, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R8	Comp, 2k, ±5%, 1/4W	1066-2025	Allen-Bradley	CB2025
R9	Comp, 2k, ±5%, 1/4W	1066-2025	Allen-Bradley	CB2025
R10	Comp, 12k, ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R11	Comp, 12k, ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R12	Comp, 3.3k, ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R13	Comp, 56k, ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R14	Comp, 56k, ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R15	Comp, 2k, ±5%, 1/4W	1066-2025	Allen-Bradley	CB2025
R16	Comp, 51k, ±5%, 1/4W	1066-5135	Allen-Bradley	CB5135
R17	Comp, 30k, ±5%, 1/4W	1066-3035	Allen-Bradley	CB3035
R18	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R19	Pot, 100k, ±10%, 3/4W	1215-0006	Helitrim	89WR
R20	Comp, 20k, ±5%, 1/4W	1066-2035	Allen-Bradley	CB2035
R21	Comp, 3.6k, ±5%, 1/4W	1066-3625	Allen-Bradley	CB3625
R22	Comp, 3.6k, ±5%, 1/4W	1066-3625	Allen-Bradley	CB3625
R23	Comp, 20k, ±5%, 1/4W	1066-2035	Allen-Bradley	CB2035
R24	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R25	Comp, 200Ω, ±5%, 1/4W	1066-2015	Allen-Bradley	CB2015

HORIZONTAL AMPLIFIER/SWEEP GENERATOR. 2200 (cont.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R26	Comp, 120Ω, ±5%, 1/4W	1066-1215	Allen-Bradley	CB1215
R27	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R28	Comp, 150k, ±5%, 1/4W	1066-1545	Allen-Bradley	CB1545
R29	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R30	Comp, 3.6k, ±5%, 1/4W	1066-3625	Allen-Bradley	CB3625
R31	Comp, 2.7k, ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R32	Comp, 1k, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R33	Comp, 3.6k, ±5%, 1/4W	1066-3625	Allen-Bradley	CB3625
R34	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R35	Comp, 330Ω, ±5%, 1/4W	1066-3315	Allen-Bradley	CB3315
R36	Comp, 2.4k, ±5%, 1/4W	1066-2425	Allen-Bradley	CB2425
R37	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R38	Comp, 2.2k, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R39	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R40	Comp, 20k, ±5%, 1/4W	1066-2035	Allen-Bradley	CB2035
R41	Comp, 24k, ±5%, 1/4W	1066-2435	Allen-Bradley	CB2435
R42	Comp, 1k, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R43	Comp, 1.6k, ±5%, 1/4W	1066-1625	Allen-Bradley	CB1625
R44	Comp, 1k, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R45	Comp, 20k, ±5%, 1/4W	1066-2035	Allen-Bradley	CB2035
R46	Metal Film, 619Ω, ±1%, 1/8W	1075-0063	Dale	MFF 1/8 T-1
R47	Metal Film, 634Ω, ±1%, 1/10W	1074-1042	Dale	MF 1/10 T-0
R48	Metal Film, 12.7k, ±1%, 1/10W	1074-1035	Dale	MF 1/10 T-0
R49	Metal Film, 130k, ±1%, 1/8W	1075-0114	Dale	MF 1/8
R50	Metal Film, 1MΩ, ±1%, 1/10W	1074-1039	Dale	MF 1/10 T-0
R51	Metal Film, 301k, ±1%, 1/10W	1074-1037	Dale	MF 1/10 T-0
R52	Comp, FSV	1066-XXXX	Allen-Bradley	CBXXXX
R53	Comp, 3.9k, ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
	TRANSISTORS			
Q1	FET, N Chan, 2N4392	1272-0054	Teledyne	2N4392
Q2	NPN, Si, 2N3565	1272-0017	Fairchild	2N3565
Q3	NPN, Si, 2N3565	1272-0017	Fairchild	2N3565
Q4	NPN, Si, 2N3440	1271-0004	RCA	2N3440
Q5	NPN, Si, 2N3440	1271-0004	RCA	2N3440
Q6	NPN, Si, 2N3565	1272-0017	Fairchild	2N3565
Q7	NPN, Si, 2N3565	1272-0017	Fairchild	2N3565
Q8	NPN, Si, 2N3642	1272-0018	Fairchild	2N3642
Q9	NPN, Si, 2N3565	1272-0017	Fairchild	2N3565
Q10	PNP, Si, 2N4121	1272-0023	Fairchild	2N4121
Q11	NPN, Si, 2N4275	1272-0016	Fairchild	2N4275
Q12	NPN, Si, 2N3440	1271-0004	RCA	2N3440
Q13	NPN, Si, 2N3642	1272-0018	Fairchild	2N3642
Q14	FET, N Chan, 2N4392	1272-0054	Teledyne	2N4392
Q15	PNP, Si, 2N4249	1272-0024	Fairchild	2N4249





NOTES:

1. RESISTORS – 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS – VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS – VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. ALL 1% RESISTORS ARE 1/10 W MIN.
7. INSTALLED IN SOME UNITS.
8. NON-POLARIZED ELECTROLYTIC CAPACITOR.

5601**0049**1

Figure 6-3. Horizontal Amplifier/Sweep Generator. 2200

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